Meeting more stringent emission standards for high fuel economy vehicles

OAAT ACCOMPLISHMENTS

NO_x Emission Control for Light-Duty CIDI Vehicles

Challenge

New EPA Tier 2 fleet average emission standards of 0.07 g/mile oxides of nitrogen (NO_x) and 0.01 g/mile particulate matter (PM) apply to light-duty vehicles (LDVs) and light-duty trucks (LDTs). The new standards decrease NO_x emissions by 87% and PM emissions by 95%. These reductions are more stringent than the emission targets for high fuel economy vehicles (80 mpg and better) originally set in 1994 by the Partnership for a New Generation of Vehicles (PNGV). New NO_x control technologies will have to be developed to meet the EPA standards.

Technology Description

Three candidate NO_x control strategies were evaluated for their ability to meet the interim PNGV target of 0.20 g/mile NOx (a 67% reduction), and ultimately the EPA Tier 2 NO_x standard of 0.07 g/mile. The first strategy, NO_x adsorbers, typically applies a reductant, usually taken from the fuel, across a catalyst to convert NO_x to benign N_2. Another approach, plasma assisted catalytic reduction (PACR), applies a rapid electrical pulse to the exhaust gas to make the emissions more reactive for conversion to N_2. A third strategy, active lean-NO_x reduction catalysts, also use a catalyst similar to a NO_x adsorber, but with a simpler reductant injection system.

Accomplishments

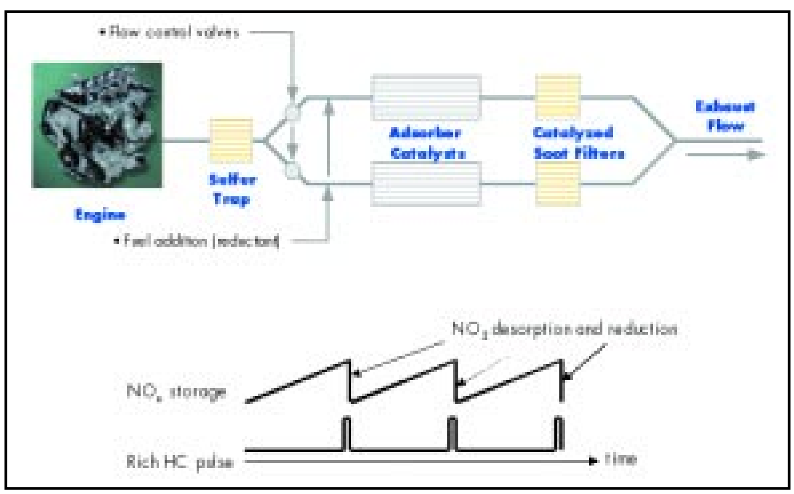
The Department of Energy/Cummins program developed a vehicle/engine/emissions performance model to evaluate candidate emission control strategies. A test cell was built to conduct Federal Test Procedure (FTP) evaluations of Cummins ISB and Ford DIATA engines. Control hardware and reductant injection systems were added to the test cell.

Only the NO_x adsorber achieved greater than 80% conversion of NO_x over operating temperatures of 250° C to 400° C. The other two NO_x control strategies only achieved 40% conversion at best, and were eliminated from further consideration.

PM emissions were addressed with a catalyzed soot filter that has been successfully demonstrated for heavy-duty applications with passive regeneration.

The catalyzed soot filter reduced PM emissions to the range of 0.01 g/mile. Filter performance was relatively insensitive to temperature.

Control devices were tested on a Cummins ISB diesel mule engine to evaluate LDT performance, and on a Ford DIATA diesel engine developed through the PNGV Program to evaluate LDV performance.



PNGV integrated NO_x + PM control system.

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Benefits

Reducing NO_x and PM emissions to meet EPA Tier 2 standards will enable high fuel economy diesel vehicles to be introduced to the market.

The data from this research can provide a foundation for any further emission reductions considered after 2008.

Future Activities

Optimum catalysts will be selected for the NO_x adsorber. Also, an optimum reductant will be derived from diesel fuel and used to develop a reductant injection system. Fuel enrichment systems will be integrated with the test systems to supply the required reductant.

An irreversible sulfur trap will be designed and developed to protect the NO_x adsorber catalyst. (The conversion efficiency of the NO_x adsorber is sensitive to temperature and deteriorates with exposure to fuel sulfur.)

The NO_x/PM system configuration will be optimized for the test engines. Options to be explored include: (1) the order of NO_x and PM catalyst placement, (2) reductant injections between catalyst bricks, and (3) full-flow versus by-pass regeneration.

NO_x adsorber effectiveness may have to be extended below 250° C where light-duty vehicles sometimes operate.

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